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Cognitive effects of Gaelic Medium Education on primary school children in Scotland

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Abstract

Research has shown that learning more than one language may have beneficial effects on executive functions, such as focused attention, inhibitory control, and switching between tasks. Evidence demonstrating these effects comes from studies with infants, children and adults from a range of language combinations. Much less direct evidence of such effects exists with regard to the bilingual experience of children acquiring regional minority languages. This study addresses the question of whether English-speaking children attending Gaelic Medium Education in Scotland exhibit differences of executive function compared with English-speaking children attending English Medium Education. Primary Five pupils from English-medium and Gaelic-medium schools in two Scottish towns were tested on three tasks of attentional control. One task, requiring verbal response inhibition, provided evidence of a significant positive effect for Gaelic-medium pupils. The results suggest that the cognitive effects of attending Gaelic Medium Education are specific to certain tasks and are affected by the characteristics of this particular bilingual setting (i.e. acquiring the second language in a domain-specific context with one dominant language). This supports the notion that the context of the bilingual experience is an important factor in shaping the cognitive effects which may be gained through exposure to more than one language.

Background

Exposure to two or more languages has been argued to equip children with advanced cognitive control when compared to children exposed to only one language (see Bialystok et al 2009; Adesope et al. 2010; Bialystok, Craik & Luk 2012; Costa & Sebastián-Gallés 2014 for reviews). While evidence for this positive effect has become broadly established, its generality has in recent years also been met with a level of scepticism (Bak 2016a). The ensuing debate provides an opportunity to develop our understanding of the cognitive consequences of bilingualism by exploring in more detail the circumstances in which they may (or may not) manifest themselves.

It has become evident that *language context* in particular is critical in shaping cognitive control processes (Green & Abutalebi 2013). Thus, if the field is to develop its awareness of how and when bilinguals differ in their performance from monolinguals, studies must be carried out in as broad a range of language contexts as possible. Focusing research on a particular bilingual setting (Gaelic-English bilingualism in Scotland) which has only recently started to be explored with regard to its effects on cognition (see de Bruin et al 2015, 2016), may provide an important contribution to the broader understanding of language development and bilingual cognition. Much of the body of research which supports evidence for the link between bilingualism and cognition has focused on bilinguals of two widely-recognised or "majority" languages (see overviews in Bialystok et al 2009; Baum & Titone 2014). Whether and how these effects manifest in a *minority* language context has been far less studied, although results relating to majority language contexts are often used in discourse around bilingualism involving minority languages (see Lauchlan et al 2012). For minority language communities, it would be advantageous to refer to research which relates directly to their experience (conflicting evidence in regard to cognitive benefits of bilingualism in minority language contexts will be discussed in detail in the section "Bilingualism and Minority Languages"). This study offers direct empirical research for the bilingual experience of those acquiring Scottish Gaelic, as a minority language in Scotland, and sets out to determine whether there are evident cognitive benefits for children acquiring Gaelic when compared with their monolingual peers.

Bilingualism and cognition

Peal and Lambert's (1962) landmark study shifted opinion towards a potentially *positive* mental effect of handling more than one language (opposing previous conceptions of a disabling effect (Saer 1922)). Since then, experimental research on the link between aspects of cognitive control and bilingualism has flourished. Particularly prominent throughout the literature are beneficial effects for bilinguals relating to two key components of executive functions (EFs) (cognitive mechanisms linked to the prefrontal region of the brain); these being *inhibitory control* and *cognitive flexibility* (as discussed below).

Inhibitory control

Much of the research into EF effects of bilingualism has revolved around aspects of inhibition or *inhibitory control* (Green 1998; Prior & MacWhinney 2010) with a beneficial effect of bilingualism widely demonstrated by different research groups (Bialystok et al 2004; Bialystok & Martin 2004; Costa et al 2009; Yang, Yang & Lust 2011; Poarch & van Hell 2012). In a general sense, this means that bilinguals tend to outperform monolinguals in the ability to block out distracting information in order to focus on what is relevant and useful to the task at hand. What is often referred to simply as 'inhibition' however, may be describing subtly different events. These can be set apart as (a) the ability to focus on salient information in the presence of distracters or conflicting cues; and (b) the ability to control an unwanted response to a deceptive cue.

(a) describes what is known as *selective attention,* with advantages found in bilinguals through tasks such as the Attentional Network Task (Yang & Lust 2004; Costa, Hernández & Sebastián-Gallés 2008; Kapa 2010) and the Embedded Figures Test (Bialystok 1992).

(b) can be further broken down into two distinct forms; "interference suppression" and "response inhibition" (Bunge et al. 2002). *Interference suppression* is used to denote the suppression of a faulty response to an irrelevant feature (thus the ability to respond to a relevant feature when faced with incongruence), whereas *response inhibition* refers to suppression of response to a habitual, or highly salient, cue – the crucial difference being the suppression of one of two conflicting responses, on the one hand, over the suppression of one response in a particular situation, on the other (Bialystok et al. 2009: 101).

A bilingual advantage in *interference suppression* is widely documented (Carlson & Meltzoff 2008; Martin-Rhee & Bialystok 2008; Luk et al. 2010) and recognised to be one of the key arenas in which the bilingual advantage resides. There is less consistency with regard to response inhibition. While it has been claimed that there is no significant difference between bilinguals and monolinguals in the control of response inhibition (Martin-Rhee & Bialystok 2008; Carlson & Meltzoff 2008; Bialystok, Craik & Luk 2008; Luk et al. 2010; Esposito, Baker-Ward & Mueller 2013), some studies have provided evidence of a beneficial effect (Bialystok & Shapero 2005; Ryan, Bialystok, Craik & Logan 2004).

Recent evidence from Grundy & Keyvani Chahi (2016) proposes that the evidence for a bilingual advantage in interference suppression may in fact reflect processing adaptations more related to selective attention and post-conflict effects. In other words, the enhanced bilingual performance found in numerous studies using conflict tasks with bivalent stimuli may be better explained by an enhanced ability to disengage attention from conflict and refocus on current demands rather than the ability to suppress a response to an irrelevant feature (Grundy & Keyvani Chahi 2016: 1). Notably, Grundy & Keyvani Chahi (2016) put forward such disengagement processes as a possible explanation for why a number of recent studies (Paap & Greenberg 2013; Gathercole et al. 2014; Antón et al. 2014) have found no bilingual advantages in conflict tasks; thus questioning interpretations that their null results challenge the existence of *any* EF advantages for bilinguals.

Cognitive flexibility

A related body of evidence (Bialystok 1999; Bialystok & Shapero 2005; Prior & MacWhinney 2010) reports bilingual advantages in *cognitive flexibility*. This effect has been demonstrated primarily through tests requiring participants to shift between two distinct, often opposing, tasks such as acting on one set of instructions and then acting on a conflicting set of instructions. This process, referred to by Miyake et al. (2000) as *mental set shifting,* is what is relied upon for the execution of *attentional* or *task switching* paradigms (Prior & MacWhinney 2010). Studies have found significantly reduced (or non-existent: Garbin et al. 2010) switching costs for bilinguals in such paradigms when compared with monolinguals.

It is however important to note that such effects may not occur for all bilinguals, depending on their bilingual experience. For instance, it has been proposed (Costa et al. 2009, Green &

Abutalebi 2013) that those with highly separated and predictable domains of use for each language – thus with a low level of switching required – may not show such advantages. Similarly, Prior and Gollan (2011) suggest that an advantage in task switching may arise only in bilinguals who frequently switch between languages. As discussed by Costa et al. (2009), the typological relatedness of language pairs and the extent to which bilingualism is widespread in a society are also factors which may impact the development of such effects.

In summary, building a picture of the occasions in which EF effects apparently do and do not occur is critical in developing our understanding of the bilingual mind. Equally important is an awareness of the myriad of confounding variables which characterise the field (see Bak 2016a for detailed discussion). In this context, bilingualism in minority language settings can provide invaluable evidence.

Bilingualism and minority languages

If differences between bilingual settings are likely to influence the impact of the bilingual experience, it is reasonable to assume that **language status** may have a role in determining bilingual effects. Due to differences in power, rights and privileges (May 2001) as well as measures of self-ascription, common descent and social orientation (Allardt 1984), minority languages tend to differ in significant ways to majority languages – particularly with regard to (i) quality and quantity of input, (ii) social status and attitudes towards the language, and (iii) motivations towards bilingualism. One crucial qualitative aspect of bilingual input is the number of speakers who interact with a child, and whether they are native or non-native (Place & Hoff 2011); this variable may affect the child's perception of the relevance and importance of the language. Another aspect is the degree of diglossia in society; that is, whether both languages are used in all contexts or whether each language is used in separate contexts. This corresponds to Abutalebi & Green's (2013) distinction between single-context environments, which favour inhibitory control, and dual-context environments, which favour frequent switching between the languages. A better understanding of these factors is likely not only to shape bilingualism in regional minority languages along social and linguistic lines, but may also shape the cognitive effects of the bilingual experience.

The previous studies exploring cognitive effects in minority-majority language bilinguals have provided a mixed picture. In Gathercole et al (2014)'s study of Welsh-English bilinguals, no cognitive effects were found using card-sorting, Simon and metalinguistic tasks. Similarly, a study of Basque-Spanish bilinguals (Antón et al 2014) found no differences between them and monolinguals. Within a Sardinian-Italian bilingual population, Garraffa, Beveridge & Sorace (2015) found limited and selective effects using tests of task switching and response inhibition. In contrast, clear advantages have been found in Catalan-Spanish bilinguals in task switching (Hernández et al 2013) and attentional control (Costa, Hernández & Sebastián-Gallés 2008). Some executive control advantages have also been evidenced in bidialectal children speaking a majority language (Standard Modern Greek) and a minority dialect (Cypriot Greek) (Antoniou et al. 2016) and in Norwegian children with bidialectal literacy in minority-majority written forms (Nynorsk & Bokmål respectively) (Vangsnes, Söderlund & Blekesaune 2015).

Research on the cognitive effects of exposure to Scottish Gaelic is very limited. One study (Lauchlan et al 2013) directly compared Gaelic-English bilingual children and Sardinian-Italian bilingual children, showing evidence of both bilingual groups significantly outperforming their monolingual (English and Italian speaking) counterparts in tests of problem solving and metalinguistic awareness. It is notable, however, that the Gaelic-English participants performed significantly better than Sardinian-Italian participants in some of the tasks. The authors suggest that the presence of Gaelic Medium Education in Scotland – and the lack of the equivalent formal education in Sardinia – may have led to a stronger level of bilingualism in the Scottish children, and therefore clearer effects in these tests of cognition. This is undoubtedly an underexplored question. While much of the research on the links between bilingual education and cognitive functioning has focused on immersion and heritage language programmes in north-American contexts such as Canada and the USA (Garcia & Baker 2007), much less attention has been paid to the cognitive effects of bilingual education in smaller bilingual communities, with some notable exceptions (e.g. Catalan – Spanish in Hernández et al 2013; Welsh – English in Gathercole et al 2014). The present study focuses on bilingualism developed in Gaelic Medium Education contexts, thus pursuing the question regarding the cognitive effect of Gaelic-English bilingual education left open by Lauchlan et al (2013).

Focus on Scottish Gaelic

Scottish Gaelic is a member of the Goidelic branch of the Celtic languages (McLeod 2014). Like many other minority languages, it has suffered displacement, suppression and subsequent decline, particularly from around the beginning of the nineteenth century (MacKinnon 1991, Macleod 2010). In the later decades of the twentieth century however, there has been a movement to establish revitalisation initiatives (MacKinnon 1988, McLeod 2006, Macleod 2010). Alongside an increase in Gaelic language media outlets, signage and use within institutions, a key element of this new momentum to maintain the language has been the growth in opportunities for children in Scotland to receive their education through the medium of Gaelic. At the time of writing, Gaelic Medium Education (GME) is available in 14 out of 32 Scottish local authorities at both primary and secondary levels (Education

Scotland 2015). There are a number of dedicated "single provision" Gaelic schools which provide GME, though the majority are "dual provision" schools; having both monolingual English-Medium and bilingual Gaelic-Medium streams within the same school. In both cases, all elements of the curriculum are taught through the medium of Gaelic for the first 3 years of primary education. English is introduced into the learning after this stage though Gaelic remains primary the language of the classroom[1].

In 2014 the Scottish Government adopted a 1+2 approach to language learning in schools which gives every child the chance to learn two modern languages additional to their mother tongue during primary school (L2 from Primary 1; L3 from no later than Primary 5) (Scottish Government 2012). With Gaelic offered as one of these languages, many more children in Scotland will have the opportunity to be exposed to the language. It is worth noting however, that while efforts to bring Gaelic in to formal education, institutions and the media indicates an important change in perceptions towards the language, revitalisation efforts which focus in these areas does not necessarily lead to, or reflect growth in, family or community language use (McLeod 2014). There is therefore still uncertainty around the future of the language and speaker numbers continue to remain in decline.

Of particular relevance to the present study with regard to language use and bilingual context, two key factors delineate the current Gaelic language situation in Scotland:

1. Scottish Gaelic has had few - if any - monolingual speakers of the language since 1981 (GROS 1983)).

[1] http://www.gaidhlig.scot/bord/education/primary-education/ [Accessed 27/04/2017]

2. With only 516 children in Scotland with Gaelic as the main home language (Scottish Government 2015: Table 1.14), intergenerational transmission of the language is "critically low" (McLeod et al. 2010: 2).

We therefore focus here on what Green and Abutalebi (2013) would describe as a 'single-language context' – one which is (a) highly domain-specific (Gaelic now tends to be acquired through immersion and used predominantly within the school (McLeod 2014)) and (b) has one clearly dominant language (most young speakers of Gaelic are strongly English-dominant in all domains (Lamb 2001)).

The Present Study

Within the context of understanding the key cognitive functions which are thought to be affected by the bilingual experience, and how minority languages in general (and Scottish Gaelic in particular) interact with bilingualism, the present study addresses the question of whether there is enhanced performance for Gaelic-English bilingual children (when compared with their English speaking monolingual peers) in aspects of cognitive flexibility and/or inhibitory control.

Methods

Participants

Sixty-four children participated in this study, from three primary schools in two Scottish towns. Children were recruited in one Gaelic-Medium school (henceforth GME-A) in one English-Medium school situated nearby (EME-A), and in one dual provision school located in a different town, with separate GME and EME streams within the same school, where children were recruited from both streams (GME-B and EME-B).

Five participants requiring learning support were excluded from the analysis. **Table 1** [Table 1 near here] displays the total remaining participants. All but one of the participants had been exposed to English from birth (one GME-A participant exposed to English from age three). No participant had significant exposure to a second (EME) or third (GME) language.

Twenty-seven boys (GME: 15, EME: 12) and 32 girls (GME: 14, EME: 18) were included in the study. All were in Primary Five with an age range of 8 years, 8 months - 10 years, 0 months (GME mean age 9.5, SD 0.3 ; EME mean age 9.5, SD 0.3). Primary Five was chosen for testing for two key reasons:

i – According to O'Hanlon, McLeod and Paterson (2010), gaps in English attainment in GME and EME pupils seem to have closed by Primary Five. There is also evidence, for GME pupils, of comparable attainment in Gaelic and English by this stage.

ii – At the time of testing, all pupils started receiving French lessons in Primary 6 (Gaelic lessons also begin at this stage for EME-B pupils). They were therefore tested one year before being exposed to instruction of a second or third language.

A parent/guardian questionnaire designed by the authors (see Appendix 1) was completed by 59% of the total participants (55% for GME / 63% for EME), providing information on socioeconomic status (SES), linguistic background of the family, language use within and outwith the home, time spent playing computer games and attitudes towards GME. Class teachers also completed a questionnaire using a 10-point scale to mark each pupil's proficiency in English (EME)/English and Gaelic (GME). See **Table 2** [Table 2 near here] for a summary of parent / teacher responses.

Tasks

The *Test of Everyday Attention for Children* battery is a clinical assessment tool used to test a range of EFs, designed specifically for children aged 6-16 years (TEA-Ch: Manly et al 1999, see also Manly et al 2001 for test norms). The adult version (Robertson et al. 1994) has successfully been used in a number of other studies to detect bilingualism effects in adults (Bak, Vega-Mendoza & Sorace 2014, Vega-Mendoza et al 2015, Bak et al. 2016). We selected the following three tasks from the TEA-Ch battery for use in our study.

Creature Counting [Figure 1 near here] Participants were presented with a trail of 'creatures' interspersed with arrows pointing up or down. The task requires the participant to count the trail of creatures aloud, switching to counting upwards or downwards as dictated by the arrows. After ensuring that participants were able to count from 1-12 and from 12-1 with ease, two demonstrations and two practice runs were given. Time and accuracy were recorded on seven different creature trails. This task requires a verbal response to a visual cue and tests the ability to switch in response to a cue.

Walk, Don't Walk [Figure 2 near here] A sheet of 'paths' (columns of 14 adjoined boxes) was presented to the participant. The task involves 'walking' (marking each box with a pen) along the paths in response to two tones played on a cassette player. One tone signified *walk* (i.e. make a mark), another tone – similar to the first though ending differently – signified *don't walk* (i.e. no mark should be made). The "don't walk" tone occurred at an unpredictable point along each path requiring the pupil to inhibit the impulse to make a mark when this sound is heard. After two repeats of both sounds, two demonstrations and two practise runs, the pupil had to 'walk' along twenty paths (through which the speed of the tones increased). Accuracy (total number of paths in which the pupil did not make a mark at the "don't walk" tone) was recorded. This task requires a motor response to an auditory cue and tests the ability to inhibit a prepotent response.

Opposite Worlds [Figure 3 near here] Participants were presented with strings of digits 1 and 2. In the 'same' (congruent) condition, the digits had to be named aloud. In the 'opposite' (incongruent) condition, 1 had to be read as 'two' and 2 read as 'one'. Two demonstrations and two practice runs were executed before the pupil completed four rounds in the order same-opposite-opposite-same. The speed with which each round was completed was measured (the demonstrator pointed to each number, moving on only when a correct response was given – thus errors incurred a time penalty). This task requires a verbal response to a visual cue and tests the ability to inhibit a prepotent response in a situation of conflicting information.

Hypotheses

The influence of bilingualism on cognitive functions is task specific and depends on the nature of the task as well as on its difficulty (Valian 2015, Bak 2016b). Accordingly, we did not expect to find an overall advantage in bilingual participants but rather a specific, task-dependent pattern of results.

Following the hypothesis that switching effects are not likely to arise in 'single language' or domain-specific contexts (Costa et al. 2009, Prior & MacWhinney 2011, Green & Abutalebi 2013) it was predicted that there would be no effect of bilingualism for the Creature Counting task. Equal performance between bilinguals and monolinguals was also expected for the Walk, Don't Walk task requiring response inhibition, which was adapted from the Sustained Attention to Response Task (SART; Robertson et al 1997), as previous studies using SART and other comparable tasks with bilingual and monolingual populations have found no significant differences in performance (Carlson & Meltzoff 2008, Luk et al 2010). The subtest in which we expected to find an effect of bilingualism was Opposite Worlds, a task requiring the ability to suppress a prepotent verbal response. Bialystok & Shapero (2005)'s study using a modified version of this task used in the present study resulted in bilingual participants significantly outperforming monolingual participants. The congruent condition of this task acts a control, reinforcing the 'prepotent' response; thus bilingual and monolingual participants were expected to perform equally in this condition.

Procedure

Written consent was obtained from parents of all participating children. All participants were tested individually by the same experimenter. The testing took place in a quiet room within the school during school hours. Three tasks were performed by each participant in a fixed order (as presented below) and carried out in English. Each session lasted approximately 25 minutes.

Analysis

Accuracy scores (total of correct trials) were recorded for Creature Counting (/7) and Walk, Don't Walk (/20). Response time scores were recorded for Creature Counting and Opposite

Worlds. Time taken to complete each trial was recorded using a handheld stop-watch. The Creature Counting time-score was calculated from the total time taken for all trials completed accurately divided by the total number of switches (directional arrows) occurring in those trials. Opposite Worlds time-scores were calculated by totalling the time taken to complete both 'same' conditions and time taken to complete both 'opposite' conditions. Task scores, language proficiency and parent education are analysed as interval measures.

Results

Background variables

An overview of participant demographics and questionnaire responses is provided in **Table 2** [Table 2 near here].

A one-way between-groups ANOVA indicated that the four groups did not differ significantly in age; $F(3,50) = 2.366$, $p = 0.08$. Neither did they differ significantly in gender, as demonstrated by the chi-square test; $\chi^2(3) = 3.508$, $p = 0.320$.

No significant differences were found in Mann-Whitney tests between *Parent Education* (the highest level of qualification attained by parents of the participants) and *Language* (GME/EME) (Mother's education: $U = 123.5$, $z = -.680$, $p = .515$; Father's education: $U = 83.0$, $z = -1.263$, $p = .240$) nor *Place* (A/B) (Mother's education: $U = 137.0$, $z = -.108$, $p = .931$; Father's education: $U = 99.5$, $z = -.377$, $p = .723$) variables.

A one-way ANOVA showed no significant difference between the four groups with regard to English proficiency scores; $F(3,55) = 2.213$, $p = 0.097$. Neither were there significant differences between the two GME groups in Gaelic proficiency; $t(27) = -0.066$, $p = 0.948$.

A Wilcoxon signed-rank test on the GME population showed a significantly higher rate of English to Gaelic proficiency; $Z = -2.291$, $p = 0.022$. When tested individually, significance was found only in the GME-B population; $Z = -2.236$, $p = 0.025$.

Task Results

Table 3 [Table 3 near here] provides a summary of the raw data gathered. Data from all task scores except *Creature Counting-Accuracy* were normally distributed. Two-way ANOVAs were used on all task scores, with language and place as between-subject factors. A main effect of *Place* was revealed in *Walk, Don't Walk*; $F(1,55) = 7.203$, $p = 0.01$ showing 'place-B' participants as achieving higher accuracy rates than 'place-A' participants. *Language* did not show an effect for this task ($p = .146$) nor did the interaction between language and place ($p = .600$). In *Opposite Worlds-Incongruent Condition* there was a main effect of *Language*; $F(1,55) = 9.441$, $p = 0.003$ showing GME participants as faster to complete this task than EME participants. *Place* did not show an effect for this task ($p = .407$) nor did the interaction between language and place ($p = .886$). Figures 4 and 5 [Figures 4 and 5 near here] illustrate these results.

No significant differences were found for accuracy or time in the *Creature Counting* task when tested against *Language* and *Place* variables. Nor did *Opposite Worlds-Congruent Condition* display any significant between-group results. Response times for this condition were significantly faster than response times for *Opposite Worlds-Incongruent Condition* for all groups; $t(58) = -12.522$, $p < 0.001$.

Discussion

The aim of this study was to examine potential differences in cognitive control, and specific executive function abilities, between Gaelic-English bilingual and English monolingual children. Three tasks were used to test different components of cognitive control in four groups of participants – two of bilingual children attending Gaelic-medium primary schools, two of monolingual children attending English-medium primary schools. As predicted, the observed pattern was highly specific. No differences between GME and EME pupils were observed in the Creature Counting and Walk, Don't Walk tasks; or in the congruent condition of the Opposite Worlds task. In contrast, GME pupils performed better than those in EME in the incongruent condition of the Opposite Worlds task.

An unexpected finding was the significantly higher Walk, Don't Walk accuracy scores of 'place-B' participants in comparison to 'place-A'. The reason for inclusion of the "place" variable in the analysis was to exclude that non-language-related differences between schools could significantly influence the results, producing spurious effects or obscuring genuine ones. Interestingly, place did influence TEA-Ch performance, but on a variable usually not associated with bilingualism.

Place vs. Language

The fact that *place* but not *language* affected performance of the Walk, Don't Walk task while *language* but not *place* affected the incongruent condition of the Opposite Worlds task suggests that, while the two places tested are not matched in EF abilities, this difference did not play a role in influencing Opposite Worlds-Incongruent Condition task scores (the task in which language background had an influence). That language background did not influence results in the Walk, Don't Walk task (nor the Creature Counting task) also demonstrates that the GME participants cannot be said to have a blanket EF advantage, due to higher SES or other intervening factors. Hence, the difference in language background is likely to be the key factor causing the significantly lower response times recorded for the GME children in the incongruent condition of the Opposite Worlds task.

Furthermore, no significant between-group difference in the *congruent* condition of the Opposite Worlds task is an indicator that the GME advantage in *incongruent* condition of the same task was not simply due to faster reading/responding abilities. This suggests that for all children, the challenging factor in the Opposite Worlds-Incongruent Condition condition was the incongruence (as illustrated by significantly slower responses to the incongruent condition than to the congruent condition in all groups) and that GME may have a specific effect on coping with this incongruence.

Switching vs. Inhibition

The equal performance of GME and EME participants in the Creature Counting task suggests that the effects of bilingualism on EF depend not only the knowledge of two languages but also on the experience of using them. In other words, in bilinguals with one dominant language, language suppression is likely to be a more relevant factor in everyday life than active switching between the languages. As has been suggested by Costa et al. (2009), Prior and Gollan (2011) & Green & Abutalebi (2013), an advantage in task switching may arise only in bilinguals who frequently switch between languages. As conversational switching is not a significant feature of the language use of most GME participants in this study (see

‘Focus on Scottish Gaelic’ above), it is unsurprising that no cognitive advantages were found in this area.

While bilingual language selection is commonly identified as the source of bilinguals’ enhanced performance in *interference suppression* over *response inhibition* tasks, some studies (Ryan, Bialystok, Craik & Logan 2004; Bialystok & Shapero 2005) have found advantages in both forms of inhibition. It is plausible that the inhibition of a habitual response may indeed reflect the linguistic experience of bilinguals with a dominant language, contrary to the claim of ‘response inhibition = no bilingual advantage’ by Martin-Rhee and Bialystok (2008) and Carlson and Meltzoff (2008) (among others). The results of the present study provide indirect supporting evidence for this claim. However, this study did not test for interference suppression. This would be an interesting element in further research with GME pupils.

The results highlight the possible trade-off relationship between task-switching and inhibitory control. It has been proposed (Blumenfeld & Marion 2010, Sorace 2011) that switching between dimensions (linguistic or otherwise) requires the release of inhibition; resulting in the two (inhibition and its release) detracting resources from one another. These trade-off effects have been discussed with regard to individuals with autism spectrum disorders (Happé & Frith 2006) and may be relevant to bilingualism if the enhanced inhibitory control brought about by the bilingual experience results in a weakened ability to integrate cues and actively switch between conflicting dimensions (Sorace 2011, 2016). Such a trade-off is likely to be most relevant to bilinguals with one clearly dominant language or bilinguals living in a diglossic community who experience high levels of inhibitory control and low levels of switching.

Walk, Don't Walk vs. Opposite Worlds

Walk, Don't Walk and Opposite Worlds-Incongruent Condition are primarily tests of response inhibition. That a GME advantage was found only in the latter (and a 'place-B' advantage found only in the former) highlights the need to analyse where the key differences lie between the two tasks. This should lead to a clearer understanding of the source of the GME advantage. **Table 4** [Table 4 near here] provides an overview of conflicting factors relevant to the two tasks.

Score measure

Only accuracy was recorded in the Walk, Don't Walk task. Any possible between-group differences in response times are thus unknown. Further studies using this task would do well to record both accuracy *and* response times to be sure to have as full a data-set as possible. Considering this, the lack of a significant difference in this task between language groups may be unsurprising in the light of evidence from other studies (Emmorey, Luk, Pyers & Bialystok 2008, Costa et al. 2008, 2009) in which bilingual advantages were found not in *accuracy* but in *speed* (see also Hilchey and Klein (2011) for their "global Reaction Time advantage" hypothesis).

The fact that Walk, Don't Walk task-scores showed significant differences between *place* variables suggests that individual differences in the particular component of EF relevant to this task do exist in the age group tested, however this component is not affected by bilingualism in Gaelic.

Response type

The other salient difference between the two tasks is their nature as motor-response versus verbal-response tasks. Further research is required to determine whether a bilingual advantage is more likely to occur in one over the other. While verbal-response tasks appear on the surface to be closer to language use than motor-response tasks, the latter in the present study involved reactions to an audio-stimulus; arguably more relevant to language use than a visual-stimulus (to which verbal responses were given). It is notable that many of the studies claiming no bilingual advantage in response inhibition are studies which involve motor-response, rather than verbal-response, tasks (e.g. Bialystok, Craik & Luk 2008, Carlson & Meltzoff 2008, Luk et al. 2010).

Limitations

Naturally, our study has several limitations. No record was taken for response times in the Walk, Don't Walk task and no control test for motor-control was carried out with participants to ensure equal measures in this task. Additional tests for *interference suppression* and *selective attention* – aspects of EF commonly associated with a bilingual advantage – would also be beneficial for future research. Testing of these functions was not included for the reason that they were not available/suitable within the TEA-Ch battery. This flags up a wider issue related to many studies of bilingual EF effects: the majority of standardised tests of EF are designed to test for deficiencies below the norm (as is the case for the tests used in the present study – see Manly et al. (2001)) rather than improvements above the norm. Thus, it becomes difficult to choose the most appropriate tests for the purpose of comparing monolingual and bilingual populations (see Valian 2015). A positive step in bilingual research would be for a wider range of tests to be designed for these purposes.

The present study did not test language proficiency in both English and Gaelic directly but did so through a 10-point scale teacher-questionnaire. It would have benefitted from the use of standardised tests of language proficiency such as the *Peabody Picture Vocabulary Test* (Dunn and Dunn 1997), but no such tests exist currently in the medium of Scottish Gaelic.

Finally, it is noted (Hilchey and Klein 2011: 643) that the 'most widespread' criticism of research on bilingualism is a failure to control sufficiently for SES. As is the case for many studies in this area, the present study would have benefitted from more stringent SES controls. However, the fact that we tested different schools in two different areas and that the comparison between them showed either no differences or, in one case (Walk, Don't Walk), a difference not related to the language of education makes it unlikely that our results could be sufficiently explained by social differences between GME and EME children.

Conclusions

The results of this study have implications with regard to both the effects of children acquiring Scottish Gaelic through the medium of education, and to the process of uncovering a more precise picture of whether, where and why bilingual EF advantages exist.

In our sample, bilinguals performed better than monolinguals in the Opposite Worlds-Incongruent Condition task, in which verbal response inhibition was the key cognitive function tested. This provides an empirical basis demonstrating that cognitive benefits can be gained in bilingualism with minority languages, and specifically in the context of Gaelic-English bilingualism where children have English as a dominant language. Additionally, the study flags up questions regarding the types of cognitive benefits which bilinguals of differing language backgrounds exhibit. The results support the proposal that bilinguals experiencing a low level of language switching may not show EF effects in task switching (*as discussed in the section on Cognitive Flexibility above*). They further indicate that response inhibition should not be disregarded as a function unrelated to a bilingual effect. In certain circumstances, the most prominent cognitive effects of bilingualism may indeed reside in this function. This evidence raises further questions with regard to how two languages are processed and whether this differs according to one's linguistic background.

Future directions which arise from this study include opportunities for further research comparing GME and EME populations using different tasks and testing different components of EF. A quantitative comparison of EF abilities in GME pupils with Gaelic from an early age in the home with those acquiring the language from a later age outside the home (as in GME) would also be a valuable next-step. Further studies focusing on different types of bilingual populations should allow the field to come closer to building consensus around the nature of the cognitive consequences of bilingualism - pinpointing where they appear, for whom and for what reasons.

In sum, this study adds to a body of evidence showing that linguistic experience has an effect at the level of executive function. It highlights the fact that these effects cannot be pigeonholed as one single phenomenon but may be manifested in different ways depending on the factors which influence the bilingual environment. It also offers further evidence for the potentially beneficial effects of Gaelic-English bilingualism in an educational context.

References

Adesope, O.O. et al. (2010) A systematic review and meta-analysis of the cognitive correlates of bilingualism *Review of Educational Research* 80 207–245

Allardt, E. (1984) What constitutes a language minority? *Journal of Multilingual and Multicultural Development*, 5:3-4 195-205. Routledge

Antón, E., Duñabeitia, J.A., Estévez, A., Hernández, J.A., Castillo, A., Fuentes, L.J., Davidson, D.J. and Carreiras, M. (2014) Is there a bilingual advantage in the ANT task? Evidence from children *Frontiers in psychology* 5:398

Antoniou, K., Grohmann, K.K., Kambanaros, M. and Katsos, N. (2016) The effect of childhood bilectalism and multilingualism on executive control *Cognition* 149 18-30

Bak, T. H. (2016a) The impact of bilingualism on cognitive ageing and dementia. Finding a path through a forest of confounding variables *Linguistic Approaches to Bilingualism* 6:1-2 205 –226

Bak, T. H. (2016b) Cooking Pasta in La Paz. Bilingualism, bias and the replication crisis *Linguistic Approaches to Bilingualism* 6:5 699–717

Bak, T. H., Vega-Mendoza, M. and Sorace, A. (2014) Never too late? An advantage on tests of auditory attention extends to late bilinguals *Frontier in Psychology* 5

Bak, T. H., Long, M. R., Vega-Mendoza, M. and Sorace, A. (2016) Novelty, Challenge and Practise: The Impact of Intensive Language Learning on Attentional Functions PLoS ONE 11: 4

Baum, S. and Titone, D. (2014) Moving toward a neuroplasticity view of bilingualism, executive control and aging *Applied Psycholinguistics* 35: 857-894.

Bialystok, E. (1992) Attentional Control in Children's Metalinguistic Performance and Measures of Field Independence *Developmental Psychology* 28:4 645-664 The American Psychological Association Inc.

Bialystok, E. (1999) Cognitive Complexity and Attentional Control in the Bilingual Mind *Child Development* 70:3 636–644. UK: Whiley-Blackwell

Bialystok, E. Craik, F., Green, D.W. and Gollan, T.H. (2009) Bilingual Minds *Psychological Science in the Public Interest* 10:3 89-129 Association for Psychological Science

Bialystok, E., Craik, F., Klien, R. and Viswanathan, M. (2004) Bilingualism, Aging, and Cognitive Control: Evidence from the Simon Task *Psychology and Aging* 19:2 290–303 The American Psychological Association

Bialystok, E., Craik, F. and Ryan, J. (2006) Executive Control in a Modified Antisaccade Task: Effects of Aging and Bilingualism *Journal of Experimental Psychology: Learning, Memory, and Cognition* 32:6 1341–1354. The American Psychological Association

Bialystok, E., Craik, F. and Luk, G. (2008) Cognitive Control and Lexical Access in Younger and Older Bilinguals *Journal of Experimental Psychology: Learning, Memory, and Cognition* 34:4 859-873 The American Psychological Association

Bialystok, E., Craik, F. and Luk, G. (2012) Bilingualism: consequences for mind and brain *Trends in Cognitive Sciences.* 16 240–250

Bialystok, E. and Martin, M.M. (2004) Attention and inhibition in bilingual children: evidence from the dimensional change card sort task *Developmental Science* 7:3 325–339 Oxford: Blackwell Publishing Ltd.

Bialystok, E. and Shapero, D. (2005) Ambiguous benefits: the effect of bilingualism on reversing ambiguous figures *Developmental Science* 8:6 595–604 Oxford: Blackwell Publishing Ltd.

Blumenfeld, H.K. and Marian, V. (2010) Bilingualism influences inhibitory control in auditory comprehension *Cognition* 118 245–257 Elsevier B.V.

Bunge, S.A., Dudukovic, N.M., Thomason, M.E., Vaidya, C.J. and Gabrieli, J.D.E. (2002) Immature Frontal Lobe Contributions to Cognitive Control in Children: Evidence from fMRI *Neuron* 33 301-311 Cell Press

Carlson, S.M. and Meltzoff, A.N. (2008) Bilingual experiences and executive functioning in young children *Developmental Science* 11:2 282–298. Blackwell Publishing Ltd.

Costa, A., Hernandez, M. and Sebastian-Galles, N. (2008) Bilingualism aids conflict resolution: Evidence from the ANT task *Cognition* 106 59–86 Elsevier B.V.

Costa, A., Hernandez, M., Costa-Faidella, J. and Sebastian-Galles, N. (2009) On the bilingual advantage in conflict processing: Now you see it, now you don't *Cognition* 113 135-149 Elsevier B.V.

Costa, A. and Sebastián-Gallés, N. (2014) How does the bilingual experience sculpt the brain? *Nature Reviews Neuroscience* 15 336–345

De Bruin, A., Bak, T. H., Della Sala, S. (2015) Examining the effects of active versus inactive bilingualism on executive control in a carefully matched non-immigrant sample *Journal of Memory and Language* 85 15-16

De Bruin, A., Della Sala, S., Bak, T. H., (2016) The effects of language use on lexical processing in bilinguals *Language, Cognition and Neuroscience* 31:8 967-974

Diamond, A. (2006) The Early Development of Executive Function *Lifespan Cognition* Ed. Bialystok, E. and Craik, F.I.M. 70-95 UK: Oxford University Press

Dunn, L.M. and Dunn, L.M. (1997) *Peabody Picture Vocabulary Test–Third Edition* Bloomington, MN: Pearson Assessments

Education Scotland (2015) Advice on Gaelic Education Available from https://education.gov.scot/improvement/gael3-advice-on-gaelic-education [accessed 23/03/2017]

Emmorey, K., Luk, G., Pyers, J.E. and Bialystok, E. (2008) The Source of Enhanced Cognitive Control in Bilinguals, Evidence From Bimodal Bilinguals *Psychological Science* 19:12 The Association for Psychological Science

Esposito, A. G., Baker-Warda, L. and Muellerb, S. (2013) Interference Suppression vs. Response Inhibition: An Explanation for the Absence of a Bilingual Advantage in Preschoolers' Stroop Task Performance *Cognitive Dev*elopment 28:4 354–363

Garbin, G., Sanjuan, A., Forn, C., Bustamante, J.C., Rodriguez-Pujadas, A., Belloch, V., Hernández, M., Costa, A. and Ávila, C (2010) Bridging language and attention: Brain basis of the impact of bilingualism on cognitive control *NeuroImage* 53 1272–1278 Elsevier Inc.

Garcia, O. and Baker, C., eds. (2007) *Bilingual Education: An Introductory Reader.* Clevedon: Multilingual Matters

Garraffa, M., Beveridge, M. and Sorace, A. (2015) Linguistic and Cognitive Skills in Sardinian–Italian Bilingual Children *Frontiers in psychology* 6:1898

Gathercole, V.C.M., Thomas, E.M., Kennedy, I., Prys, C., Young, N., Viñas-Guasch, N., Roberts, E.J., Hughes, E.K. and Jones, L. (2014) Does language dominance affect cognitive performance in bilinguals? Lifespan evidence from preschoolers through older adults on card sorting, Simon, and metalinguistic tasks *Frontiers in Psychology* 5:11

Green, D. W. (1998) Mental control of the bilingual lexico-semantic system *Bilingualism: Language and Cognition* 1 67-81 Cambridge University Press

Green, D. W. and Abutalebi, J. (2013) Language control in bilinguals: The adaptive control hypothesis *Journal of Cognitive Psychology* 25:5, 515-530

GROS (General Registrar Office for Scotland) (1983). Census 1981 Scotland Gaelic Report (A publication of the Government Statistical Service) Edinburgh: Her Majesty's Stationary Office

Grundy, J. G. and Keyvani Chahi, A. (2016) Post-conflict slowing effects in monolingual and bilingual children *Developmental Science* 20:1 1–12 John Wiley & Sons Ltd.

Happé, F. and Frith, U. (2006) The Weak Coherence Account: Detail-focused Cognitive Style in Autism Spectrum Disorders *Journal of Autism and Developmental Disorders* 36:1 5-25 Springer Science + Business Media, Inc.

Hernández, M., Martin, C.D., Barceló, F. and Costa, A. (2013) Where is the bilingual advantage in task-switching? *Journal of Memory and Language* 69:3 257-276

Hilchey, M.D. and Klein, R.M. (2011) Are there bilingual advantages on nonlinguistic interference tasks? Implications for the plasticity of executive control processes *Psychon Bull Rev* 18 625-658 Psychonomic Society, Inc.

Kapa, L.L. (2010) Executive Function in Simultaneous and Sequential Bilingual Children *M.A. Thesis.* University of Kansas
Available from **http://hdl.handle.net/1808/6945** [accessed 24/02/2017]

Lamb, W. (2001) Scottish Gaelic. Languages of the World/Materials 401. Munich: Lincom Europa [cited in McLeod 2014]

Lauchlan, F., Parisi, M. and Fadda, R. (2013) Bilingualism in Sardinia and Scotland: Exploring the cognitive benefits of speaking a 'minority'language *International Journal of Bilingualism* 17:1 43-56

Luk, G., Anderson, J.A.E, Craik, F.I.M., Grady, C. and Bialystok, E. (2010) Distinct neural correlates for two types of inhibition in bilinguals: Response inhibition versus interference suppression *Brain and Cognition* 74 347-357 Elsevier Inc.

MacKinnon, K. (1991) *Gaelic: A Past and Future Prospect*, Edinburgh: Saltire Society

Macleod, M. (2010) Language in Society: 1800 to the Modern Day. *The Edinburgh Companion to the Gaelic Language*. Ed. M. Watson and M. Macleod. Edinburgh University Press Ltd: Edinburgh 22-45

Manly, T., Robertson, I.H., Anderson, V. and Nimmo-Smith, I. (1999) *Test of Everyday Attention for Children (TEA-Ch) Manual* London: Harcourt Assessment

Martin-Rhee, M.M., and Bialystok, E. (2008) The development of two types of inhibitory control in monolingual and bilingual children *Bilingualism: Language and Cognition* 11 81-93 Cambridge University Press

May, S. (2001) *Language and Minority Rights. Ethnicity, Nationalism and the Politics of Language*, UK: Pearson Education Limited

Manly, T., Robertson, I.H., Anderson, V. and Nimmo-Smith, I. (1999) *Test of Everyday Attention for Children (TEA-Ch) Manual* London: Harcourt Assessment

Manly, T., Anderson, V., Nimmo-Smith, I., Turner, A., Watson, P., & Robertson, I. (2001) The Differential Assessment of Children's Attention: The Test of Everyday Attention for Children (TEA-Ch), Normative Sample and ADHD Performance. *The Journal of Child Psychology and Psychiatry and Allied Disciplines* 42:8 1065-1081

McLeod, W. (2006) *Revitalising Gaelic in Scotland: Policy, Planning and Public Discourse*, Edinburgh: Dunedin Academic Press

McLeod, W. (2014) Gaelic in contemporary Scotland: Challenges, strategies and contradictions. *Europa Ethnica* 71:1/2 3

McLeod, W., Pollock, I. and MacCaluim, A. (2010) Adult Gaelic Learning in Scotland: Opportunities, Motivations and Challenges. A research report for Bòrd na Ghàidhlig. Edinburgh: Celtic and Scottish Studies: University of Edinburgh

Mehmedbegovic, D., Bak, T.H. (2017) Towards an interdisciplinary lifetime approach to multilingualism: From implicit assumptions to current evidence. *European Journal of Language Policy* 9.2, 149-167

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H. and Howerter, A. (2000) The Unity and Diversity of Executive Functions and Their Contributions to Complex ‘‘Frontal Lobe’’ Tasks: A Latent Variable Analysis *Cognitive Psychology* 41 49-100 Academic Press

O’Hanlon, F., McLeod, W. and Paterson, L. (2010) Gaelic-medium Education in Scotland: choice and attainment at the primary and early secondary school stages. Bòrd na Gàidhlig

Paap, K.R. and Greenberg, Z.I. (2013) There is no coherent evidence for a bilingual advantage in executive processing *Cognitive psychology* 66:2 232-258

Peal, E. and Lambert, W. (1962) The Relation of Bilingualism to Intelligence *Psychological Monographs* 76 1–23

Place, S. and Hoff, E. (2011) Properties of dual language exposure that influence 2-year-olds’ bilingual proficiency *Child Development* 82.6: 1834-1849

Poarch, G. J. and van Hell, J. G. (2012) Executive functions and inhibitory control in multilingual children: Evidence from second-language learners, bilinguals, and trilinguals. *Journal of Experimental Child Psychology* 113 535–551

Prior, A. and Gollan, T.H. (2011) Good Language-Switchers are Good Task-Switchers: Evidence from Spanish–English and Mandarin–English Bilinguals *Journal of the International Neuropsychological Society* 17 682-691 Cambridge University Press

Prior, A. and MacWhinney, B. (2010) A bilingual advantage in task switching *Bilingualism: Language and Cognition* 13:2 253–262 UK: Cambridge University Press

Robertson, I. H., Ward, T., Ridgeway, V., and Nimmo-Smith, I. (1994) The Test of Everyday Attention: TEA *Bury St. Edmunds: Thames Valley Test Company*

Robertson, I., Manly, T., Andrade, J., Baddeley, B.T. and Yiend, J. (1997) 'Oops!': Performance correlates of everyday attentional failures in traumatic brain injured and normal subjects *Neuropsychologia* 24:5 636-647 Elsevier Science Ltd.

Ryan, J.D., Bialystok, E., Craik, F. and Logan, J. (2004) Bilingual advantages in attentional control. Poster presented at the meeting of the Cognitive Neuroscience Society, San Francisco, CA [cited in Bialystok and Shapero 2005: 603]

Saer, D. J. (1922) An Inquiry Into the Effect of Bilingualism Upon the Intelligence of Young Children *Journal of Experimental Pedagogy* 14: 25–38

Scottish Government (2012) Language Learning in Scotland - A 1+2 Approach. Scottish Government Languages Working Group Report and Recommendations
Available from http://www.gov.scot/Publications/2012/05/3670 [accessed 24/02/2017]

Scottish Government (2015) Pupil census 2015 supplementary data
Available from http://www.gov.scot/Topics/Statistics/Browse/School-Education/dspupcensus/dspupcensus15 [accessed 24/02/2017]

Sorace, A. (2011) The Bilingual Speaker [seminar presentation] October 14th. Edinburgh: University of Edinburgh

Sorace, A. (2016) Bilingualism in Minority Languages – A Science Perspective [seminar presentation] February 13th Edinburgh: University of Edinburgh

Valian, V. (2015) Bilingualism and Cognition *Bilingualism: Language and Cognition* 18 (01): 3-24

Vangsnes, Ø.A., Söderlund, G.B. and Blekesaune, M. (2015) The effect of bidialectal literacy on school achievement *International Journal of Bilingual Education and Bilingualism* 1-16

Vega-Mendoza, M., West, H., Sorace, A. and Bak, T. H. (2015) The impact on late, non-balanced bilingualism on cognitive performance *Cognition* 137: 40 - 46

Yang, S. and Lust, B. (2004) Testing effects of bilingualism on executive attention: comparison of cognitive performance on two non-verbal tests *Boston University Conference on Language Development* 5-7

Yang, S., Yang, H. and Lust, B. (2011) Early childhood bilingualism leads to advances in executive attention: Dissociating culture and language *Bilingualism: Language and Cognition* 14:3 412–422

Table 1: Total number of participants (included in analysis)

	GME-A	GME-B	EME-A	EME-B
	16	13	17	13
Total	**29**		**30**	

Table 2: Participant Demographics and Questionnaire Responses*

Variable	GME-A	GME-B	EME-A	EME-B
Age (years) **Mean (SD)** **Range**	 9.6 (0.2) 9.2-10.0	 9.5 (0.4) 8.8-10.0	 9.6 (0.3) 9.2-10.0	 9.4 (0.3) 9.0-9.9
Sex	8F, 7M	5F, 8M	12F, 5M	7F, 6M
Mother Education - Median (Median (SD))**	College 3 (1.2) *n = 11*	College 3 (0.9) *n = 5*	College - Undergraduate 3.5 (1.5) *n = 11*	College 3 (1.4) *n = 10*
Father Education - Median (Median (SD))**	College 3 (1.3) *n = 10*	Postgrad Degree 5 (1.1) *n = 5*	College 3 (1) *n = 10*	Higher/A-level 2 (1.7) *n = 8*
Computer Game Play (hours per week: mode response)	2-6	2-6	2-6	2-6
Years of Exposure to Gaelic (Mean (SD)) **Range**	7.9 (2) 5-9.7	6.6 (1.2) 4.7-8.2	--	--
Level of Gaelic use within the home (mode response)	‘simple words and phrases’	‘simple words and phrases’	--	--
Domains of usage within the home (mode responses)	‘reading stories’ and ‘helping with homework’	‘reading stories’ and ‘helping with homework’	--	--
Frequency of Gaelic use with Gaelic-speaking peers (mode response)	‘rarely’	‘sometimes’	--	--
Frequency of Gaelic use with Gaelic-speaking family friends/relatives (mode response)	‘sometimes’	‘sometimes’	--	--
Use of Gaelic on weekends and holidays (mode response)	‘some’	‘a little’	--	--
Attendance of Gaelic out-of-school clubs/activity groups (mode response)	Yes	No	--	--
Language Proficiency: (10=high, 1=low)				

English (Mean (SD))	8.2 (1.1)	8.4 (0.8)	7.9 (1.9)	7.8 (0.9)
Gaelic (Mean (SD))	8 (1.4)	8 (1)	--	--

*parent questionnaire responses → GME-Inverness: *n = 11,* GME-N.Lanarkshire: *n = 5,* EME-Inverness: *n = 10,* EME-N.Lanarkshire: *n = 9.*
**calculated from a 5-point scale allocated to response options: Standard Grade/O Level = 1, Postgraduate = 5.

Table 2: Descriptive statistics on each task by each group (raw scores)

Task	**GME-A** *(n = 16)*	**GME-B** *(n = 13)*	**EME-A** *(n = 17)*	**EME-B** *(n = 13)*
Creature Counting – Accuracy score				
Mean (SD)	4.9 (1.7)	5 (1.2)	4.3 (1.8)	4.8 (1.3)
Range	3-7	3-6	2-7	3-7
Creature Counting – Time score				
Mean (SD)	4.3 (1)	3.9 (0.6)	4.4 (0.9)	4.3 (0.9)
Range	3.09-6.29	3.03-5.6	3.14-5.8	3.3-6.76
Walk, Don't Walk				
Mean (SD)	11.3 (3.6)	14.8 (2.7)	10.3 (4.6)	12.6 (5)
Range	7-18	10-19	3-19	1-19
Opposite Worlds - Congruent condition				
Mean (SD)	24.6 (3.9)	24.4 (3.3)	26.4 (4.2)	25.2 (3.1)
Range	18.5-34	19.5-28.9	17.6-33.2	17.6-33.2
Opposite Worlds – Incongruent condition				
Mean (SD)	30.1 (5.1)	29.2 (3.9)	34.3 (5.9)	33 (3.8)
Range	23.5-44.9	23.8-35.3	24.7-47.3	27.1-39.8

Table 4: WDW and OW task summaries

	Walk, Don't Walk	Opposite Worlds
Response	Motor	Verbal
Stimulus	Auditory	Visual
Score measure	Accuracy	Response Time (accuracy included)
Other interacting factors	High level of sustained attention	Low level of sustained attention